

# Computational Fluid Dynamics Study on the Effects of RATO Timing on the Scale Model Acoustic Test

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The Scale Model Acoustic Test (SMAT) is a 5% scale test of the Space Launch System (SLS), which is currently being designed at Marshall Space Flight Center (MSFC). The purpose of this test is to characterize and understand a variety of acoustic phenomena that occur during the early portions of lift off, one being the overpressure environment that develops shortly after booster ignition. The SLS lift off configuration consists of four RS-25 liquid thrusters on the core stage, with two solid boosters connected to each side. Past experience with scale model testing at MSFC (in ER42), has shown that there is a delay in the ignition of the Rocket Assisted Take Off (RATO) motor, which is used as the 5% scale analog of the solid boosters, after the signal to ignite is given. This delay can range from 0 to 16.5ms. While this small of a delay maybe insignificant in the case of the full scale SLS, it can significantly alter the data obtained during the SMAT due to the much smaller geometry. The speed of sound of the air and combustion gas constituents is not scaled, and therefore the SMAT pressure waves propagate at approximately the same speed as occurs during full scale. However, the SMAT geometry is much smaller allowing the pressure waves to move down the exhaust duct, through the trench, and impact the vehicle model much faster than occurs at full scale. To better understand the effect of the RATO timing simultaneity on the SMAT IOP test data, a computational fluid dynamics (CFD) analysis was performed using the Loci/CHEM CFD software program. Five different timing offsets, based on RATO ignition delay statistics, were simulated. A variety of results and comparisons will be given, assessing the overall effect of RATO timing simultaneity on the SMAT overpressure environment.